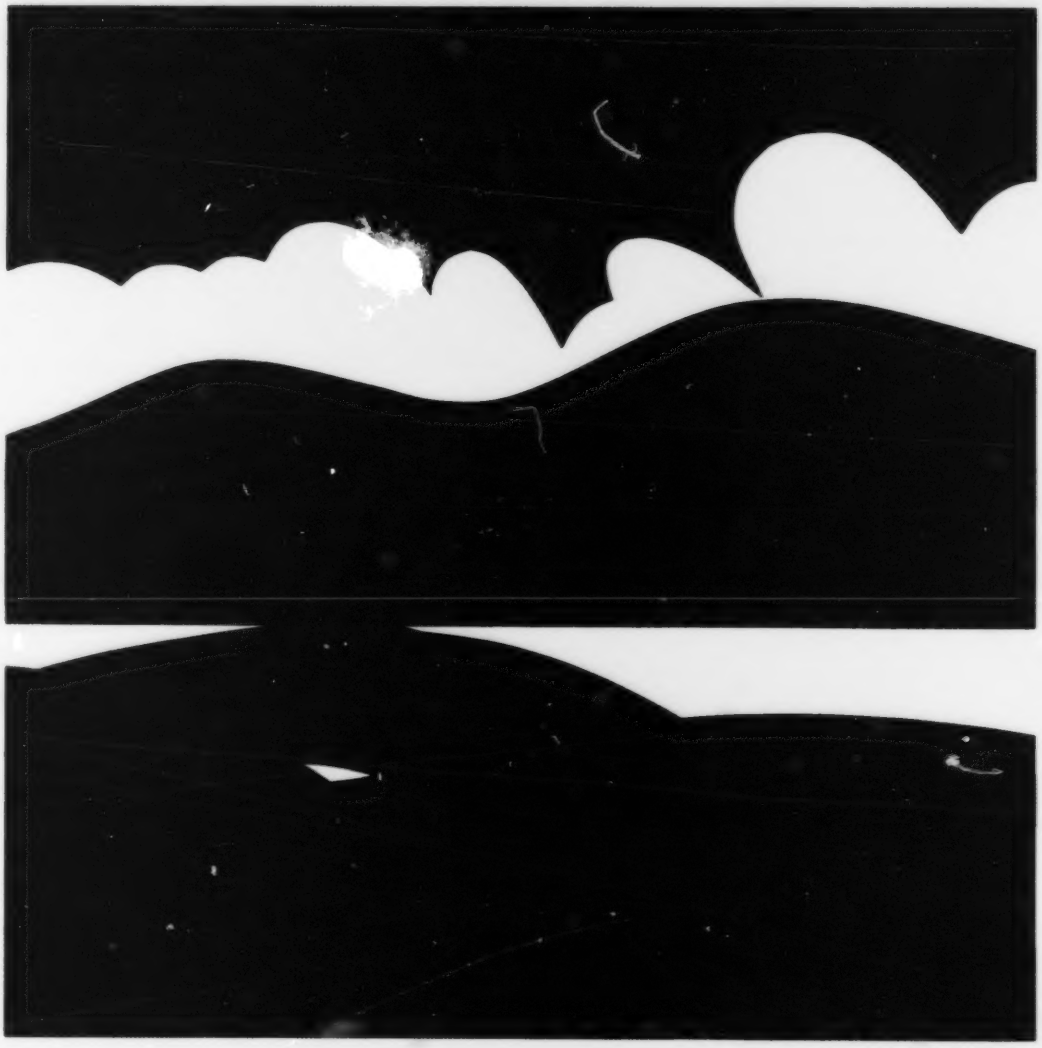
MOOSE LAKE



Alberta
ENVIRONMENT

90-00243/

Lakes attract people. And people want to know why "their" lake is the way it is — why is it so green in July? Is the water quality really deteriorating? How do our activities affect the lake?

This brochure, one of a series on Alberta's lakes, attempts to answer these questions by presenting findings of water quality studies conducted by the Environmental Assessment Division of Alberta Environment.

As you read through the brochure, you may find that you have questions about the concepts and illustrations. At the end is a section called **Explanation of Lake Characteristics**. Refer to this for further interpretation.

Brochures are available for the following lakes:

Sandy Lake	Pine Lake	Lac la Biche
Lac la Nonne	Garner Lake	Nakamun Lake
Wizard Lake	Skeleton Lake	Lac Ste. Anne
Pigeon Lake	Jackfish Lake	Baptiste Lake
Lake Isle	Island Lake	Gull Lake
Moose Lake		

July 1989

Moose Lake's scenic shoreline, sandy beaches and good fishing have made it one of the most popular lakes in the Lakeland Region of Alberta. The lake is situated about 240 km northeast of Edmonton near the town of Bonnyville. To reach the lake from Edmonton, take Highway 28 east to Ashmont, then 28A to Beacon Corner. Turn north to the village of Glendon, then east on Secondary Road 660 to Moose Lake Provincial Park. Another route is to follow Highway 28 to Bonnyville; the highway runs very close to Vezeau Bay at the east end of the lake.

Moose Lake was once known by its French name, Lac d'Orignal. Although moose are now rarely seen near the lake, the former abundance of the animal in the region no doubt inspired its name. In 1789, Angus Shaw built the Lac d'Orignal trading post at the lake for the Northwest Company.

It was not until after 1900 that settlers began to arrive in large numbers. Commercial fishing became an important industry and by 1936, three large fish-packing plants were in operation. As well, there were several mink farms around the lake.[1]

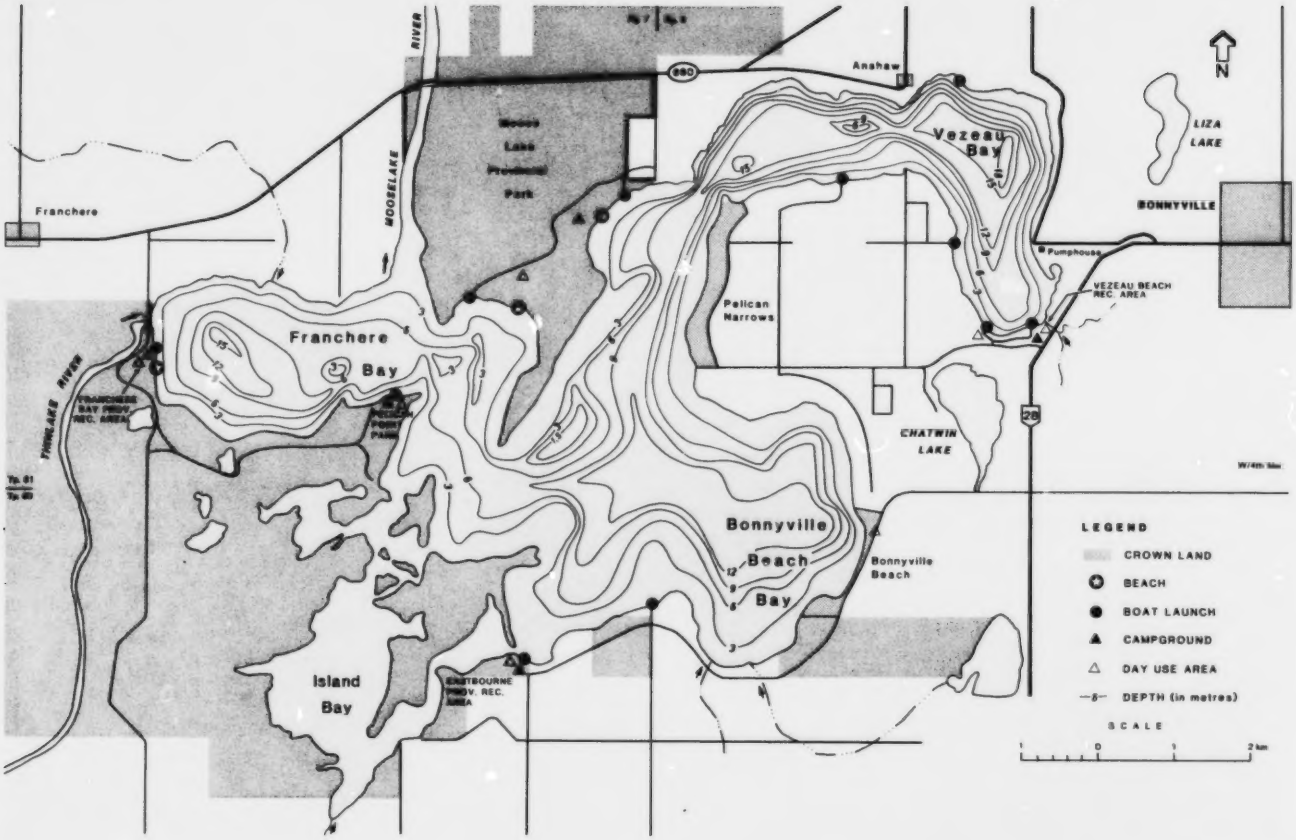
There has been intensive development on Moose Lake since the 1960s, particularly on the east shore. There are several cottage subdivisions, institutional camps, campgrounds and two summer villages - Bonnyville Beach and Pelican Narrows - around the lake. There are a total of 794 cottage lots on the shoreline, but not all of these are developed. Moose Lake Provincial Park, on the north shore, offers facilities for camping, picnicking, swimming and fishing.

Fishing

Moose Lake has excellent habitat for fish, and the lake is managed for sport, commercial and domestic fisheries. During winter the target species of the popular sport fishery is lake whitefish, and during the open-water season, the target species are walleye, northern pike and yellow perch. Anglers catch more yellow perch than other types of fish, but the catch rates for walleye and northern pike are similar to those of other lakes in the area. Other fish include cisco (tullibee), burbot, suckers, and several species of forage fish. Lake whitefish and cisco are the main commercial species.[2]

1. Glendon Historical Society. 1985. So soon forgotten - a history of Glendon and districts. Glendon.
2. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division.

Depth Contours of Moose Lake



PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

LAKE AREA[a]	km²	40.8	
DRAINAGE AREA (excluding lake)	km²	755	
DRAINAGE AREA/ LAKE AREA		18.5	
VOLUME[a]	m³	230	x 10⁶
MAXIMUM DEPTH[a]	m	19.8	
MEAN DEPTH[a]	m	5.6	
SHORELINE LENGTH	km	64.1	
TOTAL INFLOW[b]	m³/yr	56.22	x 10⁶
TOTAL EVAPORATION	m³/yr	25.9	x 10⁶
RESIDENCE TIME[b]	years	7.5	

Source: Alberta Environment, Technical Services Division

[a] On date of sounding, August 1962

[b] Excludes groundwater

Physical Characteristics

Moose Lake's shoreline configuration is quite irregular (see the Depth Contour map). There are several islands located in shallow Island Bay. Most of the lake is moderately shallow, but Vezeau Bay reaches a depth of almost 20 m.

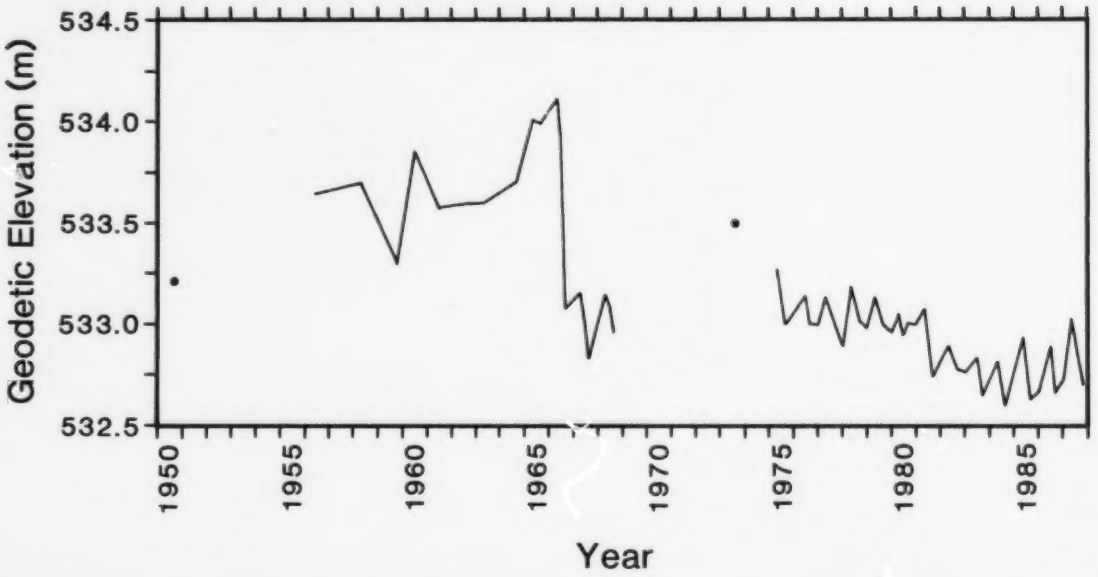
The main inlet to Moose Lake is the Thinlake River, which flows into Franchere Bay. This river and its tributaries drain most of the watershed (see the Watershed map), including several fairly large lakes. The outflow, called the Mooselake River, drains to the Beaver River. The outlet is also located on Franchere Bay. Because the inlet and outlet are so close together, it is likely that parts of the lake have a long residence time. The residence time of 7.5 years given in the Physical and Hydrological Characteristics table is an average value for the whole lake.

A weir was constructed on the Mooselake River in 1951 to maintain a suitable water level for wildlife habitat and recreation, and to ensure a water supply for the town of Bonnyville. The weir deteriorated over the years, and the lake elevation declined to its lowest recorded level in 1984 (see the Historical Water Level graph). In 1986, Alberta Environment built a new concrete weir and a vertical slot fishway; the weir is designed to stabilize the lake at a target elevation of 533.23 m.

Nutrient Sources

In most years, Moose Lake develops blooms of blue-green

Historical Water Level of Moose Lake



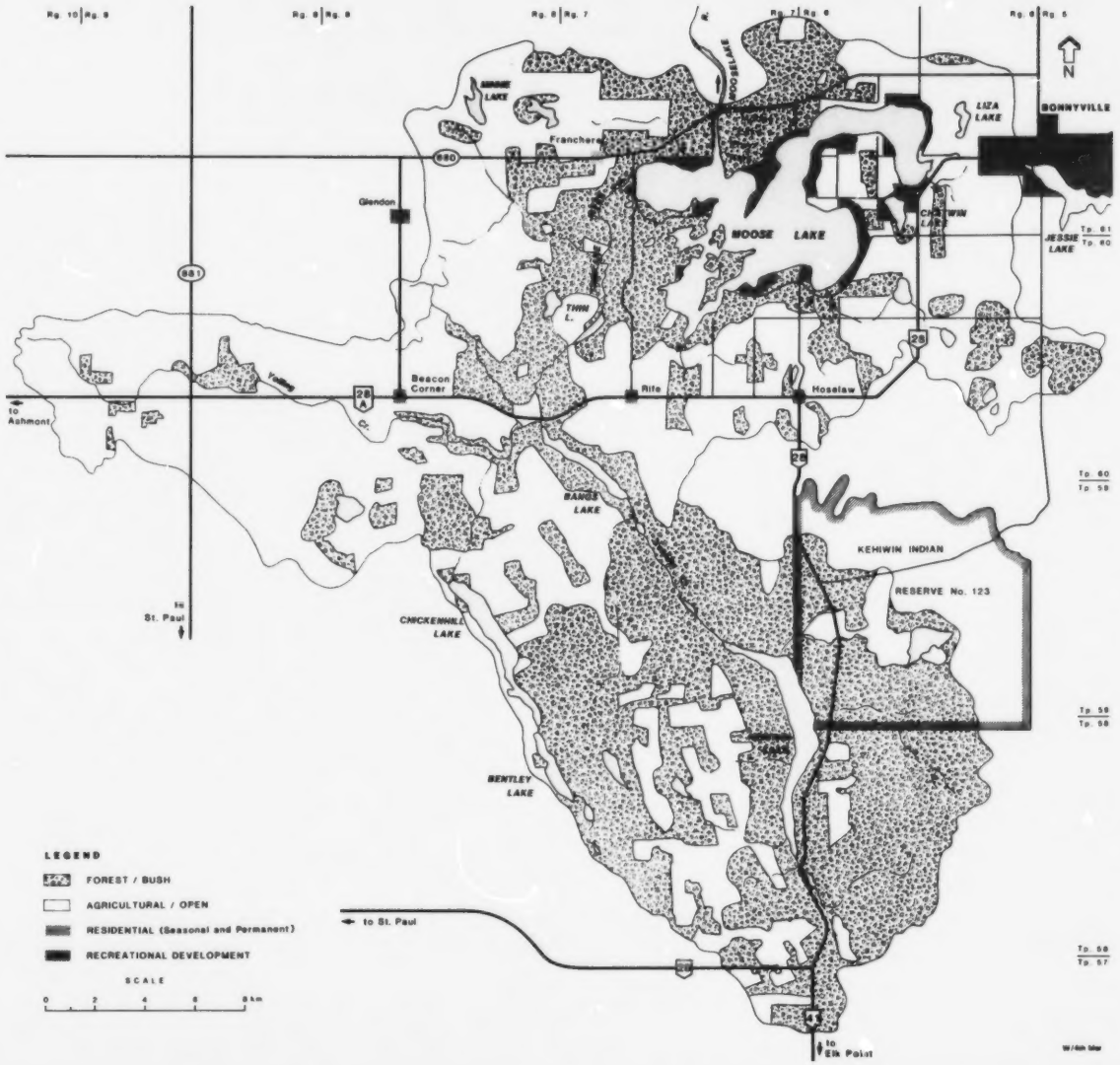
algae by late summer. These algae grow profusely in response to nutrients in the water. Phosphorus is particularly important, because in most lakes its concentration determines the amount of algae a lake will produce.

Sources of phosphorus include those outside of the lake (external sources) and the lake bottom sediments (internal source). External sources of phosphorus for Moose Lake are listed in the Theoretical External Phosphorus Supply table. Runoff from forested and cleared land during spring snowmelt and summer rainstorms contributes the largest amount of phosphorus. An additional portion falls directly onto the lake in dustfall, rain and snow, and a small portion flows in from lakes within the watershed. These lakes (see the Watershed map) trap some of the nutrients that would enter Moose Lake if no upstream lakes were present. The estimated value for sewage effluent presented in the table was not measured on Moose Lake. It was calculated from data derived from studies on other lakes.

Under certain conditions, mud or sediments at the bottom of the lake can contribute large amounts of phosphorus to the overlying water. Phosphorus has accumulated in these sediments over the 10,000 years since Moose Lake was formed. The quantity of phosphorus that is recycled from the lake bottom each year has not been estimated for Moose Lake, but it may be quite substantial.

The areal loading value provides a means of comparing annual phosphorus supplies among different lakes. The value reported in the table is fairly high, suggesting that Moose Lake is productive or fertile compared to such lakes as Island, Pigeon or Gull.

Watershed Map of Moose Lake

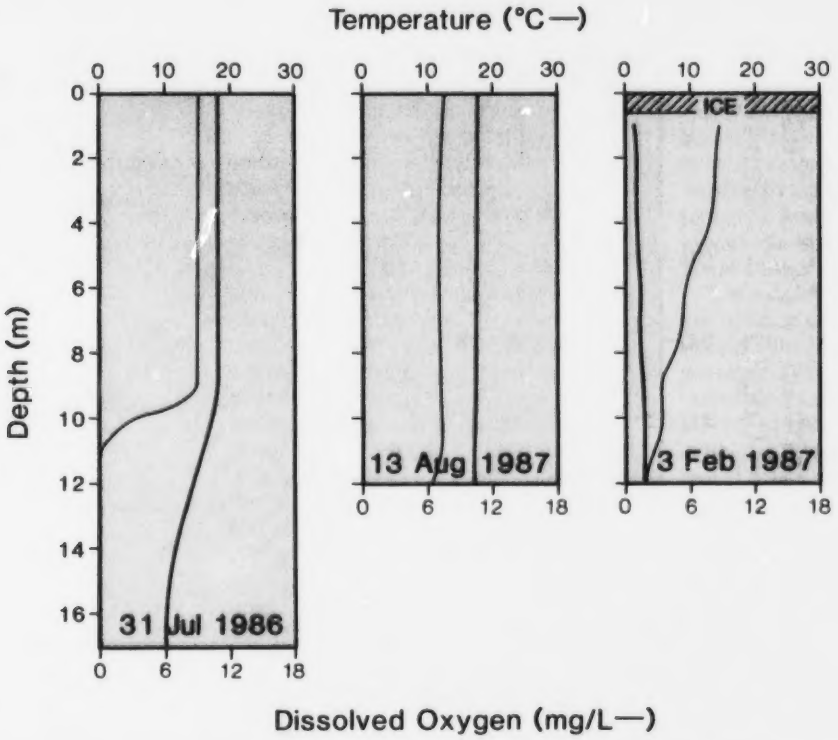


THEORETICAL EXTERNAL PHOSPHORUS SUPPLY	kg/year	percentage
SURFACE RUNOFF:		
Forested/Bush	1,998	19
Cleared/Agricultural	5,683	55
Urban/Cottage	1,247	12
PRECIPITATION, DUSTFALL	898	9
FLOW FROM OTHER LAKES	370	4
SEWAGE EFFLUENT	78	<1
TOTAL	10,274	100
AREA LOADING, g/m² of lake surface	0.25	

Temperature and Dissolved Oxygen

On windy days in summer, the water in shallow areas of Moose Lake mixes from the lake surface to the bottom, and the temperature is uniform. This can be seen on the Temperature and Dissolved Oxygen graph for 13 August 1987, which was measured in the main basin off the provincial park. On this day, the water temperature was 18°C. Because the lake was well-mixed, there was abundant dissolved oxygen, even near the bottom. But in

Temperature (°C) and Dissolved Oxygen (mg/L) in Moose Lake



deeper areas, a cool, dense layer of water that resists mixing may be present, and oxygen gradually declines as it is used up by respiration and decomposition. For example, in Vezeau Bay on 31 July 1986 (see graph), the water temperature near the bottom was only about 10°C, and there was no oxygen below a depth of about 11 m. Fish would avoid this deep area.

In winter, when the lake is covered by ice, the wind can no longer mix the water and reoxygenate it. Dissolved oxygen gradually declines, especially near the bottom. By late winter, oxygen levels may be quite low, but there is little risk of winterkill in Moose Lake.

Chemistry

The salinity (saltiness) and alkilinity of the water in Moose Lake are fairly low, and therefore it is a freshwater lake. As the Ionic Diagram shows, the dominant ions are bicarbonate (HCO_3), sodium (Na) and Magnesium (Mg). These substances are present in all lake water; the levels in Moose Lake are similar to those in many Alberta lakes.

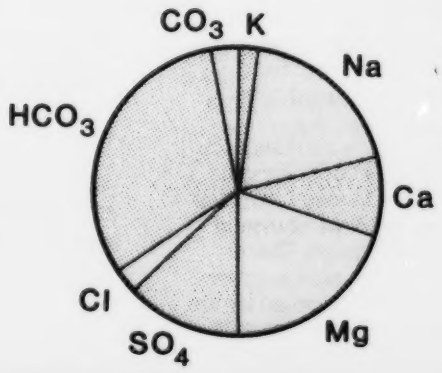
CHEMISTRY Average Values May - October, 1986-1987

CONDUCTIVITY	µS/cm*	679
pH (RANGE)		8.4 - 8.9
ALKALINITY	mg/L**	257
TOTAL DISSOLVED SOLIDS	mg/L	400

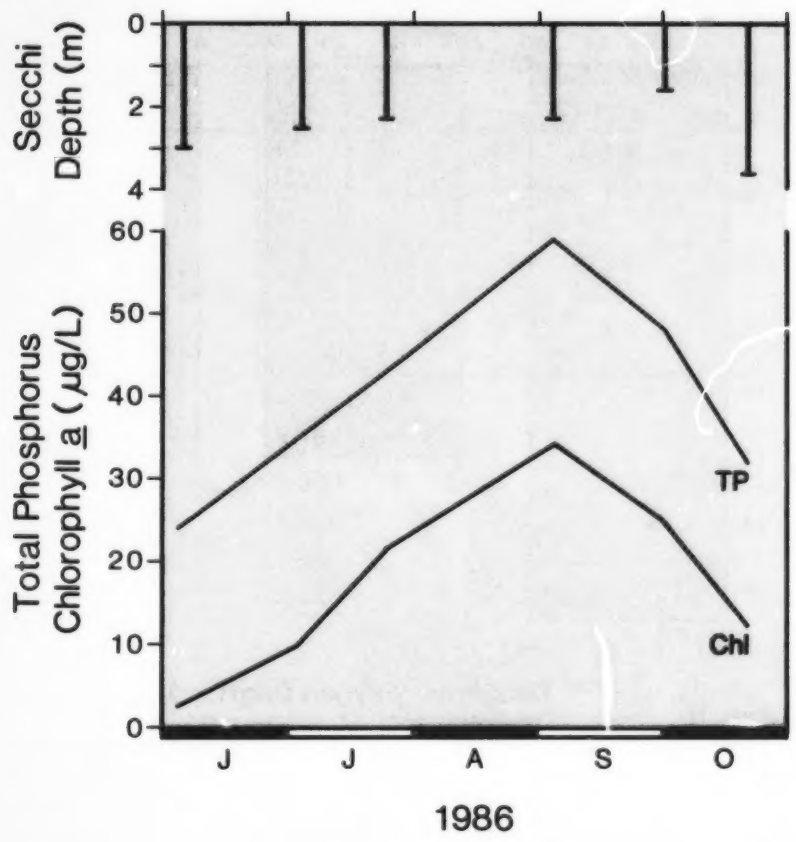
* microsiemens per cm: a measure of the resistance of water and its dissolved salts to electrical flow.

** milligrams per litre = 1/1000 of a gram in a litre of water = parts per million.

IONIC DIAGRAM - Relative Proportions of Ions in Moose Lake 1986 - 1987



Trophic Status of Moose Lake



Algae and Trophic Status

The aesthetic value of a lake is often related to its "greeness", or quantity of suspended algae. Moose Lake is fertile, or EUTROPHIC, and therefore it becomes quite green in summer. A lake's level of fertility, or trophic status, is assessed by measuring chlorophyll a (an estimate of the amount of algae) and total phosphorus in water samples collected over a summer. Secchi disk transparency also indicates fertility.

The variations in transparency and concentrations of phosphorus and chlorophyll in Moose Lake over the summer of 1986 are shown in the Trophic Status graph. There were intense blooms of blue-green algae in the lake, as revealed by the high concentrations of chlorophyll and phosphorus in early September, and the transparency was quite low. These blooms were probably fertilized by a release of phosphorus from the bottom sediments.

The Trophic Characteristics table gives average values of these indicators for 1986 and 1988.

Studies conducted in Moose Lake in 1980 and 1981, and from 1983 to 1988 show that the average amount of phosphorus and chlorophyll varies from year to year, but there is no indication that water quality is changing.

TROPHIC CHARACTERISTICS Average Values May - October

		1986	1988
PHOSPHORUS	µg/L*	40	42
CHLOROPHYLL	µg/L	18	16
SECCHI TRANSPARENCY	m	2.6	2.5
NUMBER OF SAMPLES		6	5

* micrograms per litre = one millionth of a gram in a litre of water = parts per billion.

Explanation of Lake Characteristics

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

Drainage Area or the watershed of a lake is the land surface from which a lake receives its water. As rain water or snowmelt gathers in streams, it picks up soil particles, nutrients and other materials and carries them to the lake.

A study of more than 30 Alberta lakes shows that when drainage areas are large compared to lake areas, (i.e. when the **Drainage Area/Lake Area** ratio is large), lakes have more algae (are more eutrophic) (see TROPHIC CHARACTERISTICS).

Mean Depth is the volume of the lake divided by the surface area. Shallow lakes are often more eutrophic than deeper lakes of a similar surface area.

Inflow is the total volume of water entering the lake in a year. It is related to **Residence Time**, which is the time it would take the inflow to completely fill the empty lake basin.

The **Geodetic Elevation** on the water level graph indicates the level or elevation of the lake above mean sea level.

TEMPERATURE

Alberta lakes show two basic annual patterns of temperature distribution through the water.

Deep lakes, or those protected from strong winds, form layers with the coldest water near the bottom in summer. Because this colder water is denser, it resists mixing into the warmer, lighter, upper layer.

For much of the summer, the bottom portion of water is isolated from the top portion. In spring and fall, these lakes usually mix from top to bottom by wind action as the water becomes uniform in temperature and density. In winter, under ice, the warmest water (about 4°C) is on the bottom, because water is most dense at this temperature.

Shallow lakes mix throughout the summer or layer only temporarily. In winter, the temperature pattern of these lakes is similar to that of deep lakes.

DISSOLVED OXYGEN

Oxygen is essential to the life in lakes. Oxygen from the air dissolves readily in water, especially on windy days when waves break up the lake surface. The photosynthesis of small aquatic plants also supplies a large amount of oxygen to the lake water.

Oxygen is consumed by respiration of animals and plants, and by the decomposition of dead organisms by bacteria. A great deal can be learned about the "health" of a lake by studying its patterns and quantity of oxygen.

Lakes that are unproductive (oligotrophic) will have sufficient oxygen throughout the year at all depths. But as a lake becomes more eutrophic, and increasing quantities of plants and animals respire and decay, the balance shifts towards consumption — especially near the lake bottom where dead organisms accumulate.

In deep productive lakes (see TEMPERATURE), the oxygen in the isolated bottom layer may deplete rapidly, forcing fish to move into the upper layer (fish are stressed when oxygen falls below about 3 mg/L). Fish kills occur when decomposing or respiring algal populations use up the oxygen. In summer, this usually happens when an algal bloom "collapses" or dies suddenly.

SALINITY AND TOTAL DISSOLVED SOLIDS

Lake water contains a multitude of dissolved substances. These can be seen by allowing a dish of lake water to evaporate. If the water is filtered to remove living organisms and other particles, and then allowed to evaporate, the residue is called **Total Dissolved Solids**.

The ions* that make up most of this residue can be measured individually. The **Ionic Diagram** presents all of the major ions in a lake in proportion to each other. The salinity or saltiness of the water is indicated by its **conductivity**. Water that is low in conductivity (salinity) conducts electricity poorly.

Salinity is controlled by the types of rock or soil in the watershed and by the amount of evaporation relative to precipitation. Lakes of high salinity, such as many of those found in southeastern Alberta, have fewer species of plants and animals than freshwater lakes; many are too saline to support fish.

* Ions: Chemical form in water of constituents such as sodium and carbonate.

pH AND ALKALINITY

The **pH** of lake water refers to its concentration of hydrogen ions on a scale that runs from 0 (extremely acidic) to 14 (extremely alkaline). A pH of 7 is neutral - neither acidic nor alkaline.

Most Alberta lakes fall between pH 6 to 9, with the majority on the alkaline side. **Alkalinity** refers to the capacity of water to neutralize an acid, and is a measure of the alkaline materials present in the water.

Alberta lakes that were formed in sedimentary bedrock have a large capacity to neutralize acids entering them, such as from acid rain.

THEORETICAL PHOSPHORUS SUPPLY

Lake scientists know that for most lakes, the amount of algae in the water is related directly to the amount of phosphorus. This is because phosphorus is usually in shortest supply relative to all the nutrients that lake plants need. When it runs out, the algal population can no longer increase. A larger phosphorus supply usually results in more algae.

Based on studies from all over North America, the quantity of phosphorus contributed by a hectare of forest during runoff is remarkably similar no matter where the lake is located. Similarly, agricultural or cleared land overlying sedimentary bedrock contributes fairly similar quantities of phosphorus per hectare in most lake watersheds. This was confirmed for Alberta by measuring quantities of phosphorus supplied by various land uses in several lake watersheds.

In all studies, the phosphorus supply from cleared or agricultural lake was greater than that from forest, averaging 2 to 5 times more.

The **Theoretical Phosphorus Supply** is estimated by multiplying phosphorus supply factors for each type of land use by the area of that land use, and then summing the products.

Similar factors are used for the supply from precipitation. The supply from sewage is estimated based on a percentage of the total amount that could be generated by cottages and camps on the particular lake.

It might be expected that a large phosphorus supply would produce a eutrophic lake. But the size of the lake is also important. If the total phosphorus supply is divided by the surface area of the lake, the resulting **Areal Loading** figure can be compared with other lakes, and can be used as an indication of trophic status.

TROPHIC CHARACTERISTICS

The word "trophic" literally means nourishment.

Mountain lakes usually are "poorly nourished" or **oligotrophic**. Levels of nutrients such as phosphorus and nitrogen are low, plant life is sparse, and the water is clear. Fish production is low.

On the other end of the scale are well-nourished or fertile lakes called **eutrophic**. In these lakes, aquatic plants, including tiny suspended algae, flourish because the water contains abundant nutrients.

Mesotrophic lakes, those intermediate in fertility, often combine the best features of the other two types.

In some lakes, the nutrient supply is so high that plant growth inhibits certain recreational uses of the lake. Lake users may consider such a lake to have poor water quality. One of the purposes in studying lakes is to determine whether fertility is increasing.

There are several ways to measure a lake's fertility or **Trophic Status**.

Phosphorus and **nitrogen** can be measured directly. Phosphorus in lakes of the Boreal Forest/Parkland areas of Alberta ranges between 10 and 200 micrograms per litre* (μg/L) (oligotrophic to highly eutrophic), and nitrogen ranges between 500 and 3500 μg/L.

Transparency of the water declines as a lake becomes more fertile. It is measured with a black and white plate called a **Secchi Disk**, which is lowered through the water on a line marked at metre intervals. The depth at which it can no longer be seen is the **Secchi Transparency**.

The quantity of algae in the water can be determined by measuring its content of **Chlorophyll a**, the green photosynthetic pigment.

* equivalent to parts per billion

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